PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P120PC/AH	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/SE00/00135	International filing date *(day/month/year)* 21.01.2000	Priority date *(day/month/year)* 21.01.1999
International Patent Classification (IPC) or national classification and IPC7 G01T 1/20		
Applicant Petersson, Sture et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

   I ☒ Basis of the report

   II ☐ Priority

   III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   IV ☐ Lack of unity of invention

   V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   VI ☐ Certain documents cited

   VII ☐ Certain defects in the international application

   VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
14.08.2000	02.03.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Telex 17978 PATOREG-S	Authorized officer Peter Göransson / JA A Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE00/00135

I. Basis of the report

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed

☐ the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the drawings:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE00/00135

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-8	YES
	Claims		NO
Inventive step (IS)	Claims	1-8	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-8	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The claimed invention relates to a fabrication method for producing a structured high resolution scintillating device based on light guiding of secondary produced scintillating photons for use in an X-ray pixel detector device with an image detector chip. Further, the claimed invention also comprises a scintillating device for simultaneously maintaining resolution and increased sensivity for X-ray radiation in an imaging arrangement. The structured high resolution scintillator is fabricated by forming a silicon pore matrix presenting a pore spacing corresponding to the image detector pixel size, by utilising silicon etching techniques. The silicon pore matrix is used as a mold when melting a scintillator material into the pores to form in each pore a single scintillating block in order to eliminate grain-boundary scattering of scintillating photons. Advantages according to the invention is that it can handle thick scintillating material layers with a maintained resolution which corresponds to the individual pixel size and that the fabrication technique is fast, as for a mass scale production type, and relies on existing processes and machinery.

Cited documents in the International Search Report of 8th June 2000:

D1: US, 5 496 502, A
D2: US, 5 149 971, A
D3: EP, 0 534 683, A2
D4: US, 5 519 227, A
D5: US, 5 294 795, A
D6: US, 4 533 489, A

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

None of the cited documents reveals a fabrication method for producing a structured high resolution scintillating device, by utilising silicon etching techniques and by forming a silicon pore matrix that is used as a mold when melting the scintillator material into the pores to form, in each pore, a single scintillating block in order to eliminate grain-boundary scattering of scintillating photons. Further, none of the cited documents shows a scintillating device for simultaneously maintaining resolution and increased sensivity for X-ray radiation in an imaging arrangement, by utilising the above explained fabrication method. The invention according to the independent claims 1 and 5 of the present invention therefore fulfils the requirements of novelty according to Article 33(2).

Further, it is not considered as common practice to a person skilled in the art, with the knowledge of the cited documents D1-D6, to achieve an invention according the invention stated in claims 1 and 5. Consequently, the invention according to these claims, 1 and 5, fulfils the requirement of inventive step according to Article 33 (3). The invention according to claims 1 and 5 also fulfils the requirement of industrial applicability stated in Article 33 (4).

The dependent claims 2-4 and 6-8 disclose further features of the invention, which also fulfil the requirements stated in paragraphs (2-4) of Article 33.

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International Bureau

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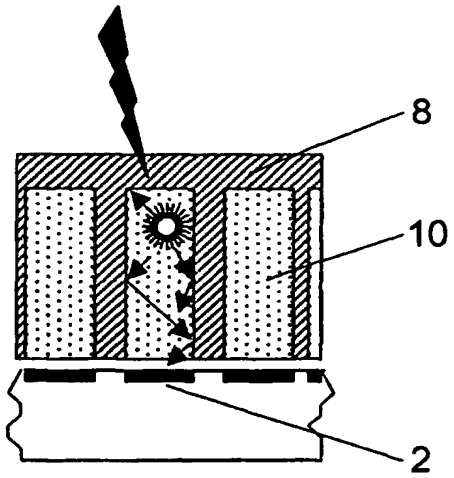
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: X–RAY PIXEL DETECTOR DEVICE AND FABRICATION METHOD

(57) Abstract

A method and a device are disclosed for producing an X–ray pixel detector, i.e. an imaging detector for X–ray photons, the detector presenting high efficiency combined with high resolution for obtaining a high image quality detector while at the same time minimizing the X–ray dose used. The application is particularly important whenever the X–ray photon absorption distance is much longer than the required pixel size. The arrangement according to the present invention presents a structure based on light–guiding of secondarily produced photons within a scintillating pixel detector in conjunction with, a CCD or a CMOS pixel detector. The structure according to the invention presents a matrix (8) having deep pores (10) fabricated by high–aspect ratio silicon etching techniques producing very thin walls and with a pore spacing less or equal to the size of a pixel (2) of the image detector used. The pore matrix is subsequently filled by melting a scintillating material into the pores such that, in each pore, a single scintillating block is formed. The silicon matrix (8) may further utilize a reflective layer to increase light guiding down to the image detector chip.



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X-ray pix l d t ctor devic and fabrication method

TECHNICAL FIELD

The present invention relates to an X-ray pixel detector, and more exactly to a pixel-camera based imaging detector for X-ray photons with high efficiency combined with high resolution.

BACKGROUND

Silicon devices as CCDs and CMOS pixel detectors are frequently used for X-ray imaging. Due to the low stopping for X-rays in silicon, the detector is generally coated with a scintillating layer. When using scintillating layers for imaging there is a trade-off between quantum efficiency and resolution. In order to get high quantum efficiency for X-rays the layer should be made thick, but that will reduce the spatial resolution in the image. The quantum efficiency for X-rays is one of the most critical parameters for medical X-ray imaging devices since the signal to noise ratio in the image depends on the number of X-ray photons contributing to the image. Since photoelectric absorption is a single event an X-ray photon will either be fully absorbed or pass unnoticed through the detector.

X-ray generators for dental X-ray imaging operate with an accelerating voltage of 60 – 90 kV giving mean photon energy in the range 30 – 40 keV. The material thickness required to stop 80 % of the X-ray photons is in the range 150 – 500 μm for the commonly used scintillators. The primary interaction between the photon and the material, photoelectric absorption, is a single event. The light in the scintillator is then generated by a large number of secondary reactions taking place within a few microns from the location of the primary interaction. As a result a flash of light is generated close to the spot of the primary interaction and radiated in all directions. The quantum efficiency for X-rays is then related to the probability for the primary interaction to occur and to a very small extent to the secondary interactions. In the energy range of interest for such an application and with the materials used as scintillators the primary interaction is generally a

photoelectric absorption. Compton scattering and other events are less likely to occur.

The light generated in the scintillator is projected onto the sensor with a spot size, which is proportional to the distance between the point of interaction and the position of absorption in the sensor. The projection is also affected by the refractive indexes of the materials the beam will pass. For a typical combination of scintillator and CCD, the scintillator thickness should be less than 100 μm to achieve a spatial resolution > 10 line-pairs/mm, as required for dental X-ray imaging.

A method to improve the spatial resolution of thick scintillating layers is to define pixels in the scintillator, as proposed in EP-A2-0 534 683, US-A-5,059,800 and US-A-5,831,269 and to make sure that the light generated within one pixel is confined within that pixel. Pixel definition in scintillators can be done in a number of ways, e.g. columnar growth of scintillator crystals or groove etching in scintillating films. In EP-A2-0 534 683 dicing or cutting is suggested for separating scintillator elements from a large scintillator block, as appropriate for larger lateral dimensions.

The method for columnar growth of scintillating crystals is well known. It has been used to grow CsI for many years. The document WO93/03496 discloses for instance growth of separate columns in different scintillators whereas in US-A-4 663 187 a scintillator is held close to the melting point resulting in the formation of domains. The disadvantage of techniques for growth of separated columns is that the columns tend to grow together for thick layers and that light will leak to adjacent columns. It is difficult to apply a light reflector between the columns.

Etching of grooves in scintillating materials is considered to be extremely difficult due to the high aspect ratios required by the application. With a pixel size of 50 μm and an allowed area loss of less than 20 % the groove width should be less than 5 μm. If the film thickness is 200 μm the aspect

ratio will be 40. This aspect ratio can only be realised by advanced silicon processing techniques whereas etching techniques for scintillating materials are far less developed. Nevertheless, US-A-5,519,227 claims that laser-based micro-machining techniques could be used to define narrow grooves in a scintillating substrate. However, the technique is inherently slow as the laser needs to be scanned several times in every groove. Furthermore, it is not clear whether re-deposition onto the walls will occur as a result of this laser ablation, which could potentially block a narrow groove.

Summarising, various techniques have been proposed for the fabrication of a scintillator array that would provide light guiding of secondary photons to an underlying imaging detector. These techniques are all restricted in one or several aspects: either too large lateral dimensions (cutting, dicing), problems of forming a well-defined narrow wall (laser ablation), cross talk between adjacent pixels (columnar growth technique) or a lengthy processing time (valid for most of these techniques). Finally, deposition of a reflective layer in the grooves is usually suggested to improve light guiding and reduce cross talk. But, none of these fabrication schemes have proposed a detailed scheme how the reflective layer would be produced. This is not an easy task considering the narrow pore geometry and materials involved.

Therefore there is still a desire to develop a device and it's associated fabrication method, which should be able to handle thick scintillating material layers but with a maintained resolution which corresponds to the individual pixel size. Furthermore, the fabrication technique should preferably be fast, as for a mass scale production type, and relying as much as possible on existing processes and machinery.

SUMMARY

The objective of the present invention is to design and develop a fabrication method for an X-ray pixel detector, i.e. an imaging detector for X-ray photons presenting high efficiency combined with high resolution to obtain a high image quality detector while at the same time minimizing the X-ray dose

used. The application is particularly important whenever the X-ray photon absorption distance is much longer than the required pixel size.

It is proposed to take advantage of the mature processing tools of the silicon microelectronics technology where lateral dimensions on a micrometer scale may readily be achieved. Thus, a silicon mold is fabricated by high-aspect ratio etching of a silicon substrate for form an array of pores. This array is subsequently oxidized to provide a low refractive index layer in contact with each individual scintillator block, formed by melting a scintillating material into the pores.

A scintillator device according to the present invention presents a structure based on light guiding of secondarily produced scintillating photons in a pixel detector in conjunction with, for instance, a CCD or a CMOS pixel detector. The structure according to the invention presents a matrix having deep pores created by thin walls presenting a pore spacing appropriate to the image detector in use, and may utilize a reflective layer on the walls of the matrix to increase light guiding down to the image detector chip.

The method according to the present invention is set forth by the attached independent claim 1 and further embodiments are defined by the dependent claims 2 to 4. A scintillator device is set forth by the independent claim 5 and further embodiments are defined by the dependent claims 6 to 8.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by making reference to the following description taken together with the accompanying drawings, in which:

FIG. 1 illustrates a silicon CCD pixel detector for direct irradiation by X-rays;

FIG. 2 illustrates a pixel detector as of FIG. 1 but provided with a thin scintillator for increasing its efficiency for X-ray radiation;

FIG. 3 illustrates a pixel detector as of FIG. 1 provided with a thick scintillator for further increasing the efficiency for X-ray radiation, but then loosing resolution;

FIG. 4 illustrates a CCD pixel detector using a thick pixel scintillator residing inside pores formed in a matrix material according to the present invention for maximum sensitivity and maintained resolution;

FIG. 5 is a more detailed view of the structure forming pores for increasing the efficiency of a CCD pixel detector; and

FIG. 6 is an enlargement of a portion of a pore indicating an extra layer of silicon oxide for improving the wall reflecting properties.

DETAILED DESCRIPTION

General features

The most developed etching techniques exist for silicon processing. According to the present application a grid is created by etching rectangular holes in a silicon wafer. The holes can be etched to a certain depth or go all the way through the wafer. The holes are then filled with scintillating material.

The performance of such a device strongly depends on how well the holes are filled, the transparency of the scintillator and the reflection properties of the walls of the hole.

The present X-ray pixel detector concept is for clarity compared to existing technology demonstrated in Figures 1 to 4. FIG. 1: A standard silicon CCD

arrangement has a very low efficiency for X-ray photon detection, normally of the order of a few per cent. This is because the penetration depth of X-ray photons, at energies of the order 40 keV, is of the order of 1 cm in silicon and thus the fraction absorbed within the active CCD layer is small.

The efficiency will preferably be increased significantly by using a scintillating material emitting a large number of visible photons for every absorbed X-ray photon as is indicated in FIG. 2. Typical absorption lengths for X-ray photons, at energies of the order 40 keV, are several 100 μm. As already mentioned a layer of the order 300 μm of CsI is needed to absorb about 80 % of the X-ray photons. Thus, for thick scintillating films as indicated in FIG. 3, almost all X-ray quanta may be absorbed, which results in a high efficiency detector. However, the trade-off is resolution, which becomes much worse as the scintillator emits photons isotropically, such that nearby pixels will also detect a significant number of photons. An alternative route is to use a thin scintillating film (of about same thickness as a pixel size) as indicated in FIG. 2, but at the expense of a much lower efficiency.

Finally, in FIG. 4 is shown the concept of the invention resulting in both high efficiency and high resolution. Here, a thick scintillator is used which has been patterned into pixels corresponding to the size of the pixels of the image detector, e.g. a CCD, in such a way that the scintillator pixels also serve as light guides which confine the emitted photons to the same pixel element only. Thus, no cross talk between pixels takes place and, depending on the pixel thickness (length perpendicular to the CCD surface) up to 100 % of the incoming X-ray photons may be absorbed. However, in order to achieve a large effective detection area the spacing between pixels must be short, e.g. for a typical 44 μm pixel size a 4 μm gap between pixels results in ~82 % efficiency due to the 'dead area' in between pixels. Clearly, to minimize cross-talk pixels may be reflection coated or the medium in between should be highly absorbing.

The fabrication of pixels having a thickness of 300 μm and a gap of about 4 μm from a scintillating material is not an easy task. The present invention therefore benefits from the mature silicon process technology using a silicon matrix wherein corresponding pores have been fabricated and successively filled with a scintillator material. The fabrication technology involves more or less standard silicon fabrication technologies such as Deep Reactive Ion Etching (DRIE), oxidation and/or metallisation. A schematic drawing of the structure is shown in FIG. 5 where 3 pixels are displayed together with a close-up of the wall structure between adjacent pixels being demonstrated in FIG. 6. In essence, the structure contains three different materials to provide the light-guiding effect the processing of which is accomplished one after the other:

Silicon pore matrix

The silicon pore matrix of the present application may be fabricated using two different techniques: Deep Reactive Ion Etching (DRIE) or Electrochemical etching. DRIE is now an established technique and several hundred μm deep pores may be fabricated. It has been found that it is possible to make, for instance, 40 x 40 μm square-formed pores with a wall thickness of 3 - 4 μm (representing ~80 % active area) and with a depth of a few hundred μm. A similar structure may be formed by electrochemical etching of silicon starting from pore initiation cones made by conventional lithography and non-isotropic etching.

Wall reflection layer

Scintillating materials usually have an index of refraction (for CsI n = 1.79) which is significantly lower than that of silicon (n = 3.4). Thus, the major fraction of scintillating photons impinging on the pore walls will penetrate into the silicon (Si) matrix unless some reflection coating of the pore walls has been provided. Therefore, this simple structure will have much lower efficiency since no light guiding exists. In the silicon matrix the light will be quickly absorbed due to the high absorption coefficient for visible light in silicon. However, note that this is a clear advantage of the present invention,

as opposed to several of the structures cited in the Background paragraph, as it totally eliminates any cross talk between pixels.

To provide light guiding a reflecting layer must be introduced at the walls. This may be accomplished either by oxidation or by coating with a metal layer. Whereas silicon dioxide is much more stable during subsequent processing, metal coating provides better reflection. In the case of an oxide, a total reflection results whenever the entrance angle is larger than the result of the expression $\arcsin(n_2/n_1)$, where n_2 and n_1 represents a respective refractive index. The reflection results in a light-guiding cone propagating upwards and downwards in the pore, see FIG. 5. The difference to a metal-coated pore (where all light would be guided in the pore) is, however, not that large as light rays impinging on the walls close to normal incidence correspond to very long path lengths before reaching the image detector cell and thus absorption is more likely.

Finally, a reflecting layer at the bottom of the pore (or at the top surface for a pore structure, which is transparent) is highly desirable in order to redirect and collect photons emitted in the upward direction.

Filling with scintillating material

Filling of the pores with scintillating material is a crucial step. Extensive tests have proved that filling of the pores with scintillating powder without melting does not yield an operational device structure. This is because grain boundary scattering of the light results in a very short penetration distance. An index-matched fluid could possibly circumvent this problem but the low effective density of the scintillator powder (large unfilled fraction) would then demand very deep pores.

Due to this fact our invention involves melting of the scintillating material to form single or polycrystalline blocks of scintillator material within each pore. For this purpose we have used CsI as a suitable material as it does not decompose upon melting. The melting and filling should be carried out in a

vacuum to reduce problems with air bubbles in the pores, which significantly affects efficiency and the light guiding ability of the pores.

In summary, the present invention is based upon light guiding of secondarily produced scintillating photons in a pixel detector in conjunction with, for instance a CCD camera or a corresponding device. The three ingredients of the preferred embodiment of the structure are:

a) A matrix with deep pores, thin walls and a pore spacing appropriate to the image detector chip in use

b) A reflective layer on the walls to increase light guiding down to the image detector chip

c) A suitable scintillating material which is melted into the pores to form a single scintillating block in order to eliminate grain-boundary scattering

In addition, the invention concerns a suitable fabrication method to realize this structure in an efficient way suitable for mass production.

It will be understood by those skilled in the art that various modifications and changes may be made to the present invention without departure from the scope thereof, which is defined by the appended claims.

CLAIMS

1. A method for fabricating a structured high resolution scintillating device based on light guiding of secondary produced scintillating photons for use in an X-ray pixel detector device with an image detector chip (1), **characterized by** the steps of

fabrication of a silicon pore matrix (8) presenting a pore spacing (10) corresponding to the image detector pixel size (2), by utilizing silicon etching techniques such as deep reactive ion etching, electrochemical techniques or other techniques providing high-aspect ratios such that thin pore walls of thickness reaching down to a few micrometers will be maintained for an active detection area optimization;

using the silicon pore matrix (8) as a mold when melting a scintillator material into the pores to form in each pore a single scintillating block in order to eliminate grain-boundary scattering of scintillating photons.

2. The method according to claim 1, **characterized by** the further step of providing, after etching but before molding, a reflection layer for light guiding by oxidation of the silicon pore matrix (8) or by deposition of any layer having a resulting refractive index being lower than that of the used scintillator material.

3. The method according to claim 1, **characterized by** the further step of, after etching but before molding, depositing a metallic reflective layer in the pores.

4. The method according to any of the preceding claims, **characterized by** the further step of producing a pore spacing being less than the image detector pixel size (2) to provide a structure without the need for alignment to the image detector chip (1).

5. A scintillating device for simultaneously maintaining resolution and increased sensitivity for X-ray radiation in an imaging arrangement, **characterized by** utilization of a fabrication method producing a silicon pore matrix (8) presenting a pore spacing (10) corresponding to an image detector pixel size (2), the pore matrix having deep pores (10) presenting thin walls of a thickness reaching down to a few micrometers to create a pore spacing corresponding to the pixel size (2) of an image detector chip (1), the pore matrix (8) further containing scintillating material which is melted into the pores (10) to form in each pore a single scintillating block in order to eliminate grain-boundary scattering of scintillating photons.

6. The device according to claim 5, **characterized by** a reflective layer (12) onto the thin walls of the matrix to increase light guiding down to the image detector chip (1).

7. The device according to claim 5, **characterized in** a pore spacing being less than the image detector pixel size (2) to thereby provide a structure without need for alignment to the image detector chip (1).

8. The device according to claim 6, **characterized in** a pore spacing being less than the image detector pixel size (2) to thereby provide a structure without need for alignment to the image detector chip (1).

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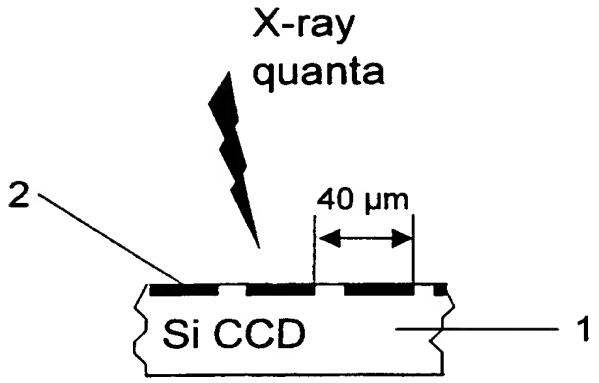

Fig. 1

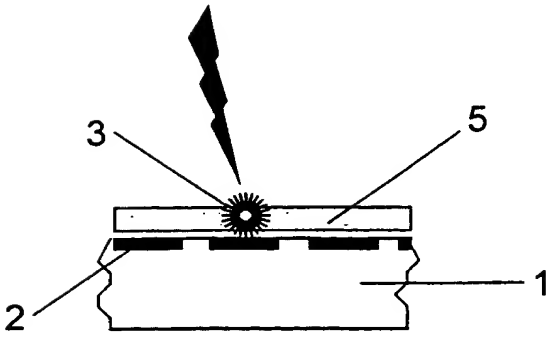

Fig. 2

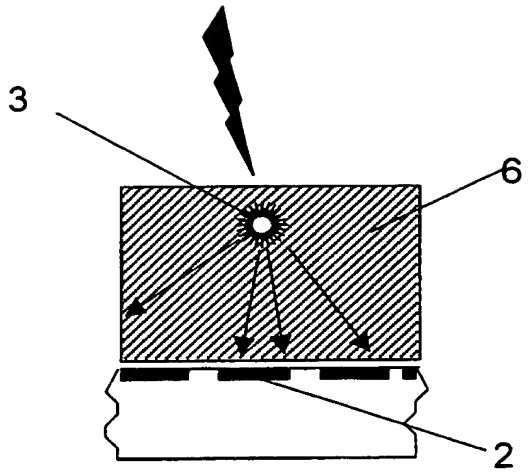

Fig. 3

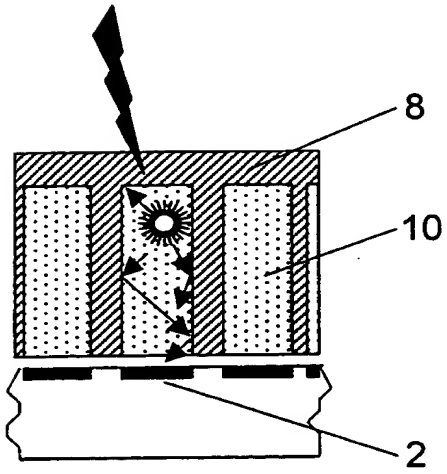

Fig. 4

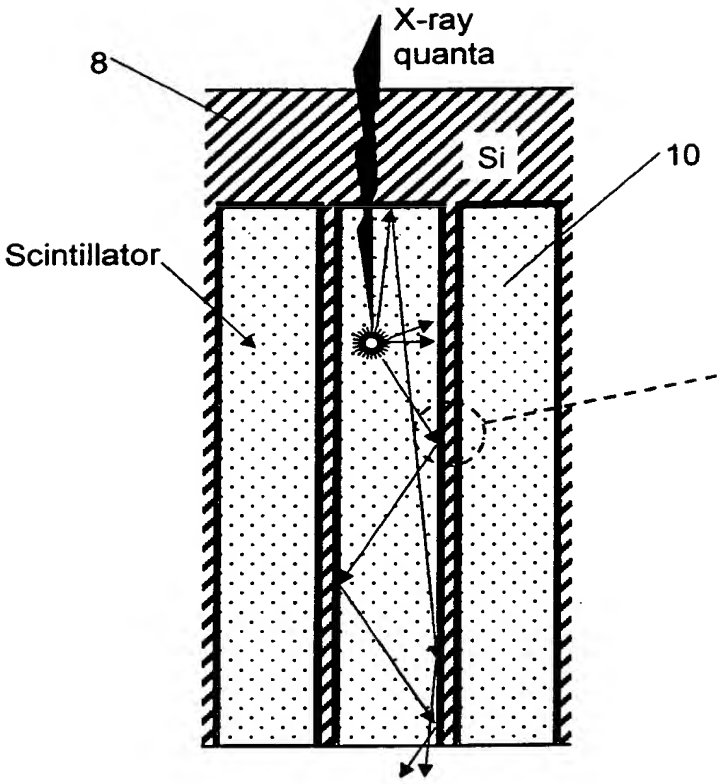

Fig. 5

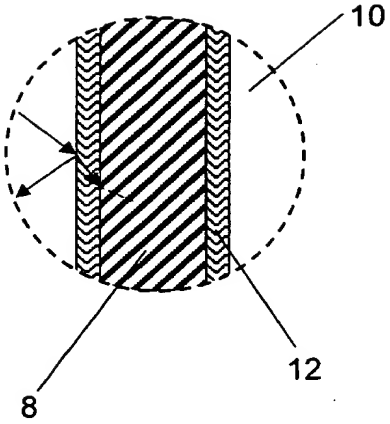

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/00135

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01T 1/20
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5496502 A (J. THOMSON), 5 March 1996 (05.03.96), column 6, line 9 - line 11; column 8, line 17 - line 37; column 9, line 17 - line 24, figure 3b --	1-8
A	US 5149971 A (S.A. MCELHANEY ET AL), 22 Sept 1992 (22.09.92), column 4, line 49 - column 5, line 7, figure 5, claims 1,13 --	1-8
A	EP 0534683 A2 (GENERAL ELECTRIC COMPANY), 31 March 1993 (31.03.93), column 2, line 46 - column 3, line 7, figures 1,2 --	1-8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 June 2000	09 -06- 2000
Name and mailing address of the ISA/ Sw dish Patent Office Box 5055, S-102 42 STOCKHOLM F csimile No. +46 8 666 02 86	Authorized officer Peter Göranss n / MR Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/00135

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5519227 A (A. KARELLAS), 21 May 1996 (21.05.96), column 2, line 31 - line 50, figures 1a,2a,2b --	1-8
A	US 5294795 A (K. LEHTINEN ET AL), 15 March 1994 (15.03.94), column 3, line 25 - line 44, figure 2b --	1-8
A	US 4533489 A (B.K. UTTS ET AL), 6 August 1985 (06.08.85), column 5, line 31 - line 49, figure --	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.
PCT/SE 00/00135

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5496502 A	05/03/96	NONE	
US 5149971 A	22/09/92	NONE	
EP 0534683 A2	31/03/93	NONE	
US 5519227 A	21/05/96	AU 3365995 A	07/03/96
		US 5572034 A	05/11/96
		WO 9605505 A	22/02/96
US 5294795 A	15/03/94	NONE	
US 4533489 A	06/08/85	AU 574410 B	07/07/88
		AU 3625784 A	13/06/85
		EP 0146255 A	26/06/85
		JP 60150002 A	07/08/85

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

HEDBERG, Åke
Aros Patent AB
P.O. Box 1544
S-751 45 Uppsala
SUÈDE

ANKOM
2000 -04- 17

Date of mailing (day/month/year) 11 April 2000 (11.04.00)	
Applicant's or agent's file reference P120PC/ÅH	**IMPORTANT NOTIFICATION**
International application No. PCT/SE00/00135	International filing date (day/month/year) 21 January 2000 (21.01.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 21 January 1999 (21.01.99)
Applicant PETERSSON, Sture et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

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Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
21 Janu 1999 (21.01.99)	9900181-0	SE	05 Apri 2000 (05.04.00)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

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Authorized officer

Carlos Naranjo

Telephone No. (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
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ETATS-UNIS D'AMERIQUE

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Date of mailing (day/month/year) 04 October 2000 (04.10.00)	
International application No. PCT/SE00/00135	**Applicant's or agent's file reference** P120PC/ÅH
International filing date (day/month/year) 21 January 2000 (21.01.00)	**Priority date** (day/month/year) 21 January 1999 (21.01.99)
Applicant PETERSSON, Sture et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

14 August 2000 (14.08.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Claudio Borton
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